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Comparison of Inventory Control with P and Q Model for Ppe At Power Plant Industry (Case Study: Pt. Pjb Ubjom Pltu Indramayu)

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Abstract: *The success of inventory management can be seen from the suitability of the available material and the material used. Research carried out in the power plant company about inventory management of personal protective equipment in the form of masks and gloves. Fluctuating material demand causes overstock and stockout so that operator and maintenance work is constrained. The purpose of this study is to obtain an optimal inventory system policy. Optimal inventory is able to meet user needs and low inventory costs. The method used in this research is P models policy and Q models policy because of the probabilistic demand characteristics. the Q model policy is able to provide greater cost savings than the P model policy. The total savings using the P model policy is Rp. 4,219,970, - and the Q model is Rp. 5,099,733, -.*

Keywords*: Inventory System, P Models Policy, Q Model Policy*

I. INTRODUCTION

The fuel uses for the power generation process s coal. The coal uses for the combustion process was powder-like and as smooth as flour because it has been through the grinding process. Coal burning ash contains many hazardous substances in the form of gas. The gases contained in the combustion are sulfur dioxide, nitrogen dioxide, carbon dioxide and also fine dust. It is important for workers in the power plant area to always wear masks because coal ash is very dangerous to humans. Coal ash will disturb the human respiratory system if inhaled, the K3 division requires every employee who entered the generation area to use a Personal Protective Equipment (PPE) to match the area visited.

This study discusses the inventory of consumable PPE, consumable PPE inventory must always be maintained for operational activities of the unit because there were no work restrictions using an appropriate PPE. PPE consumables that are often used are gloves and masks because it is very important to use them when working to maintain safety and health at work. Safety first is a concept that must be held and implemented by workers. Working in the power plant area has a high risk. These risks can be avoided by always obeying the rules set by K3 in the company. Worker safety and health will directly affect the

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reliability of the unit. When work accidents occur, companies will spend more to cover workers' maintenance costs. Worker health is also important to maintain worker productivity and to improve the reliability of generator units.

From the field observation that during 2019, it was found that the supplies of gloves and masks had run out and excess inventory. Data on the supply of gloves and masks is shown in Figures 1 and 2.

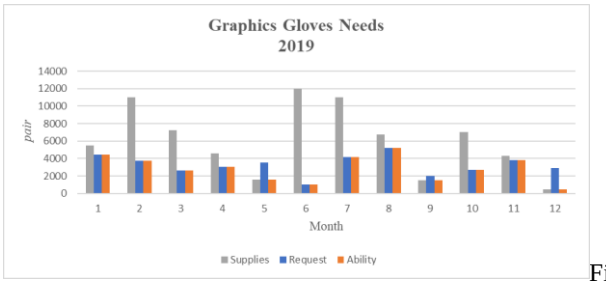

Fig. 1. Chart of Gloves

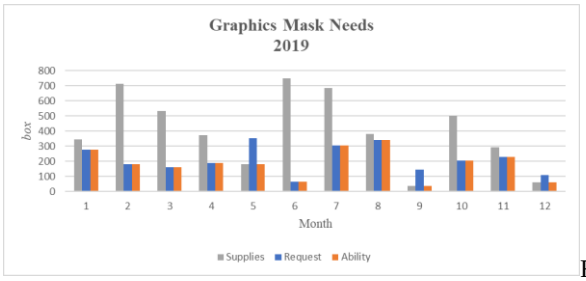

Fig. 2. Chart of Mask

This resulted in the works in maintenance division is hampered when PPE was used up because the K3 division did not allow workers without PPE equipment to enter the area that was required to use PPE. The problem of excess stock also occurred because the storage space exceeded its capacity. The purpose of this study is expected to provide suggestions for improvement in the inventory system by providing a comparison of existing inventory systems with inventory systems using the probabilistic method of the P and Q model back order, as well as providing a comparison of the minimum cost of total inventory.

Probabilistic inventory has two policy models, namely the policy model P and the policy model Q. The policy model Q has two main parameters namely the optimal order lot size (Q) and the optimal reorder point (r). Value (Q, r) is obtained from the results of repeated calculations to obtain an optimal value. The model Q policy is different from the P model which has a fixed order period parameter.. Model Q policies are better when it comes to provide inventory cost savings compared to model P [1]. The model P policy indicates that inventories will be checked at a fixed predetermined time interval and reorder will be made to raise inventory levels [2] The reorder parameter (r) and the optimal order quantity (Q) must be found for the optimal value in the Q model policy [3]. Other studies also prove that the Q model policy can reduce total inventory costs by optimizing optimal order quantity values, reorder points and safety stock [4].

II. PROBABILISTIC INVENTORY

2.1 Probabilistic Inventory Models

The assumption to be met for the EOQ model, is product demand (D) is known, constant, and uniform, constant price per unit, per unit per year (H) constant cost, constant order (S), constant lead time, and none shortage of goods [4]. Probabilistic

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inventory model is characterized by the behavior of the demand and lead time which can not be certainty known in advance it needs to be approached with a probability distribution [5]. The condition causes the need for inventory with the uncertainty of reserves to dampen fluctuations for a certain time. With the safety stock, then there will be additional costs in the additional inventory storage. This model uses the basic formula of EOQ, but coupled with optimal safety stock calculations taking into account variations in demand during the lead time so that the minimum costs incurred. The amount of reserves that is set at the maximum demand is reduced by an average demand; this means to determine the reserves that must be known how much the maximum demand.

1. The cost of purchase (*Ob*), the purchase price / production per unit. Ob is a multiplication of the number of items purchased (D) at a price of goods per unit (p).

2. The cost of booking (*Op*), which are expenses incurred for booking every time a message. The cost of the message is obtained by multiplying the frequency of booking (f) and charges each time ordering of goods (A).

3. Keep costs (*Os)*, ie costs incurred due to storage of the product at a certain period. The cost of saving is estimated by multiplying the average amount of inventory in the warehouse (m) with a cost savings per unit per period (h).

4. The cost of inventory shortages (*Ok*), the consequences of non-fulfillment of the order, it can be shaped deficiency can be ordered again (backorder) or canceled (Lost sales).

Equations total inventory costs (*OT*) can be seen in equation 1:

$OT = Ob + Op + Os + Ok$

In the processing used several assumptions to simplify the problem. The assumptions used in this study are:

a. Demand is probabilistic and normal distribution.

b. Between the time constant for each booking orders, goods come together.

c. The price of goods is constant on the quantity / time

d. The cost of the message (A) constant for each booking and the cost savings and (h) is comparable to the price of goods and storage time

e. The cost of inventory shortages comparable to the amount of goods that can not be serviced, or worth the time (not depending on the amount of the shortfall).

2.2 P Model Policy

Inventory policy with P models with regard to the determination of the stock operations which must be provided along with a spare seat. Model P solves three problems, namely: The amount of goods for each booking (Q): When the booking is made (T) and the amount of reserves (Ss). Model P begins with determining the period between booking (T) are assumed to be constant. Then determine the magnitude of the economic order (qo) for each period T that magnitude can be different between each order. Next, determine the value of reserves (ss) should be provided to dampen demand with irregular fluctuations, by balancing cost optimization and customer service. Model P can be done with the assumption Lost sales or back order.

This model is only valid if the shortage is treated with a back order. In this case, the user waits until the requested items are available. The calculations in the model back order is as follows:

1. Calculate the value of the booking time interval (To) with equation 1

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$$To = \sqrt{\frac{2A}{Dh}} \quad (1)$$

2. Calculate the value of possible shortages of inventory (α) using equations 2.

$$\alpha = \frac{Th}{Cu} \quad (2)$$

3. Calculate the expected maximum inventory value (R) using equation 3.

$$R = DT + DL + Z_\alpha S\sqrt{L + T} \quad (3)$$

4. Calculate the total cost (OT) with equations 4 and 5

$$N = \sqrt{S + T}\,[f(Z_\alpha) - Z_\alpha \Psi(Z_\alpha)] \quad (4)$$

$$D_T = D_p + \frac{A}{T} + h\left(R - DL - \frac{DT}{2}\right) + \left(\frac{C_u N}{T}\right) \quad (5)$$

5. Make monetization step 2 to change: To = To + ΔTo

a. If the total cost of the new value (OT) 1 is larger than the total cost of the initial (OT) 0, then iterations to increase To be discontinued. Then try iteration reduction (To = To - ΔTo) to get value To can memeberikan minimum total cost value.

b. If the value of total costs of new (OT) 1 less than the cost of the initial total (OT) 0 early, then iterating the addition (To = To + ΔTo) followed up with if found total costs of new (OT) 1 greater than the total cost in advance (OT) n. Price To which gives the smallest total costs (OT) is the optimal time interval

2.3 Q Model Policy

[6] Probabilistic Method Model Q with Back OrderCalculation of this raw material inventories using the first involved with probabilistic inventory models without constraints (Model (Q, r)) with Back Order Policy. Where in the solution using the equations that are calculated simultaneously through several iterations with counting procedures as follows: The settlement step is done by determining the values of *qo* and *r*, obtained by the following steps

1. Calculate value *qo*1 the beginning is the same as the value *qo* with equation 6

$$qo1 = \frac{\sqrt{2\mathrm{AD}}}{\mathrm{h}}$$

2. Based on value *qo*1 obtained will be able to look for the possibility of lack of inventory α can be searched using equation 14. And calculations r1 can be searched using equation 7

$$\alpha = \frac{hqo}{CuD}$$

$$\mathrm{r1} = DL + z\alpha S\sqrt{L}$$

3. Thus the r1 obtained can be calculated the value of *qo2* based on the formula obtained from equation 8.

$$qo2 = \sqrt{2D[A + CuN]}/h$$

4. Recalculate the value of α = hq02 / CuD and the value *r2* using equation 9.

$$\mathrm{r2} = DL + z\alpha S\sqrt{L}$$

5. Compare the values of r1 and r2; if the price of r2 is relatively the same as r1 iteration is complete and r = r2 and *qo* = *qo*2 will be obtained. If not, return to step c by replacing the values r1 = r2 and *qo*1 = *qo*2

6. The expected total cost per year can be calculated by equation 10

$$OT = Dp + \frac{AD}{qo} + h\left(\frac{qo + r - DL}{2}\right) + CU\left(\frac{D}{qo}\right)x\,N$$

III. METHODS

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This research was done on a powerplant company in Central Java Province, Indonesia. The research was based on the inventory and procurement management case study. The object of this research was the availability of gloves and masks as personal protective equipment for workers. The calculation of the inventory management system was based on a set of gloves and masks inventory and procurement data on 2019. There are four steps that need to be done in this research. The first step was to carry out field observations to find the problems, identify problems and find the data needed. The purpose was to formulate the inventory problems that occur in the company and create limits and scope of research.

The second step was to deepen the inventory problem that occurred. This step was done by conducting a study of literature related to inventory management. The purpose of the literature study was to obtain information about how to solve problems related to inventory. The next step was conducting an analysis and evaluate the system which currently operated by the company that dealt with inventory problems. The analysis was to calculate the cost of inventory incurred by the company based on the policies used at that time. The final step was to develop existing inventory management for the better. This step was used to find the right method by comparing it with the others and can be used to overcome inventory problems. The most suitable method parameter was the one with the minimum inventory cost.

Inventory policy methods used in this research was probabilistic Q model and P model with backorder case. Probabilistic Q model started from finding the demand distribution pattern data. After that, determine the order quantity, reorder point, service level, and safety stock. The result of the equation used to calculate the total of the incurred costs. Probabilistic P model started by obtaining the optimal material booking interval. The basic difference of Q and P model was the ordering quantity of Q model was always fixed but the ordering period was different, whereas the order period of the P model would remain the same but the order quantity could be different. The total inventory cost used as a reference to determine the right method.

IV. RESULT AND DISCUSSION

4.1 Existing Inventory Policy

The inventory policy adopted by the company was based on the previous year's data demand. From these data, the company could determine the quantity of material ordering and reorder points. The quantity of ordered materials always different for every re-order because the number of the orders was based on the remaining inventory in the warehouse. The company was less able to meet user demands because it had experienced a number of stockouts. In addition, the company also often experienced overstock. The impact of these problems was the cost of the shortages and storage costs became bigger. In the end it would also have an impact on the total cost per year. The total inventory cost for masks was Rp. 7,350,467, - and the total cost of the inventory of gloves was Rp. 144,240,395, -. Details of inventory costs can be seen in Table 1.

Table 1. Inventory Cost Existing

Material	Ob	Op	Os	Ok	OT
Mask	Rp 45.876.079	Rp 1.569.000	Rp 4.587.608	Rp 5.317.780	Rp 57.350.467
Glove	Rp 117.509.492	Rp 1.569.000	Rp 11.750.949	Rp 13.410.954	Rp 144.240.395

4.2 P Model Policy

P model policy results in a fixed re-order period (T) was 5 months for masks and 3 months for gloves. The quantity of the re-orders was based on the remaining expected inventory and maximum inventory (R). the Safety stock of P model policy was implicitly represented in R [7]. The calculation of order quantity was the difference between the maximum inventory and the

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remaining inventory. The expected total cost for mask supplies was Rp. 55,262,682, - and for gloves was Rp. 142,108,182. Details of the inventory costs of the P policy model can be seen in Table 2.

Table 2. Inventory Cost P Model Policy

Material	Ob	Op	Os	Ok	OT
Mask	Rp 52.523.304	Rp 1.260.169	Rp 1.282.082	Rp 197.126	Rp 55.262.682
Glove	Rp 137.669.056	Rp 2.040.192	Rp 2.111.691	Rp 287.272	Rp 142.108.210

4.3 Q Model Policy

Model Q policy dealt with optimum order quantity (q_o), reorder point (r) and safety stock (Ss). In this policy, the order quantity and the reorder point would always be the same. The order period depended on the reorder point value so that the order period will be random. The results of the calculation of the values of q_o, r and Ss mask are 1147 boxes, 25 boxes and 10 boxes. The results of the calculation of the values of q_o, r and Ss for gloves are 11132 pairs, 371 pairs and 146 pairs. The total inventory cost for the mask was Rp. 54,927,852. The total inventory cost for gloves was Rp. 141,563,272, - Details of the inventory costs for the Q policy model can be seen in Table 3.

Table 3 Inventory Cost Q Model Policy

Material	Ob	Op	Os	Ok	OT
Mask	Rp 52.523.304	Rp 1.170.936	Rp 1.196.978	Rp 36.634	Rp 54.927.852
Glove	Rp 137.669.056	Rp 1.897.308	Rp 1.947.440	Rp 49.473	Rp 141.563.277

4.4 Data Analisys and Discussion

The P model policy and the Q model policy were the approaches commonly used to solve inventory problems that had a fluctuating number of requests of each period. If the inventory policy was not good enough, the impacts were stocked out and overstock. Model P produced a fixed reorder period and reorder quantity based on the difference between the desired maximum inventory and the remaining inventory when an order was made. Q model produced the optimal order quantity, reorder point, and safety stock.

The inventory policy of the company had lower initial costs, but the cost of saving and shortage costs are higher when compared to the P and Q models. The total cost of the existing inventory policy was smaller than the P model, but was greater than the Q. The results of P and Q models were almost the same; the calculation on ordering costs, saving costs, and shortage costs. But the total cost of Q model was smaller. By looking at the total cost calculation, the company was recommended to use the Q model policy. The total savings obtained if using the Q model policy was Rp. 5,099,733. The total savings obtained if using the P model is Rp. 4,219,970. The details of total savings can be seen in Table 4.

Table 4 Total Cost Savings

Material	Model Q		Model P	
	Presentase	Cost Savings	Presentase	Cost Savings
Mask	4%	Rp 2.422.615	4%	Rp 2.087.785
Glove	2%	Rp 2.677.118	1%	Rp 2.132.185
Total		Rp 5.099.733		Rp 4.219.970

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By seeing the results of the total cost savings, the company was recommended to use the Q model policy. Other reserch Also showed that using the Q model policy saved more inventory costs compared to the P model[1]

5. Conclusion

The current inventory policy implemented by the company had a large total inventory cost compared to Model P and Model Q. Model P was ordering costs, storage costs, and inventory shortage costs that were slightly larger than Model Q which resulted in a total inventory cost of the Model P being bigger. The total inventory cost for Model P is Rp. 55,262,282, - for masks and 142,108,210, - for gloves. The total inventory cost of the P model is greater when compared to the Q model which has an inventory cost of Rp. 54,927,852 for mask and Rp. 141,563,277. The Q model policy provides more cost savings in inventory if applied at the company.

The inventory policy recommendation for the company was the Q policy model because it could save a total inventory cost. Model Q was able to save a total inventory cost of Rp. 2,422,615, - for masks and Rp.2,677,118, - for gloves. The cost savings can be applied with the optimal value of quantity, reorder points and safety stock of 1147 boxes, 25 boxes and 10 boxes for masks. Optimization results from the Q model for gloves are 11132 pairs, 371 pairs and 146 pairs.

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